AIR QUALITY THUNDER BAY

Annual Report, 1979

Ministry of the Environment
Ontario

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TECHNICAL SUPPORT SECTION
NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

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CONTENTS

SUMMARY

An air quality monitoring programme in Thunder Bay was initiated by the Ministry of the Environment in 1963. By 1979, the instrument network had expanded to 16 sites and included measurement of dustfall, suspended particulate matter, soiling index, sulphur dioxide, and total reduced sulphur. Special surveys were also conducted in 1979 in the vicinity of selected local industries.

Average dustfall complied with the Ontario objective at all but two of 16 sites. Dustfall solutions were usually acidic. Grain dust and road dust were important components of insoluble dustfall. The overall average dustfall for Thunder Bay declined 10 percent from 1978 to 1979, and 40 percent from 1973. The average concentration of suspended particulate matter, however, increased in 1979 compared with 1978, mainly because of high readings at one location in the spring and early summer. Despite this increase, the overall average for 1979 was still 30 percent below the comparable figure for 1973. The significant improvement in dust levels in recent years is mainly attributed to the multi-million dollar dust control programme now virtually complete at the 12 operating grain elevators.

Concentrations of heavy metals in suspended particulate matter were consistently below maximum acceptable levels. Nitrate and sulphate concentrations were also usually low, with occasional high readings ascribed to long-range transport.

Sulphur dioxide exceeded the 1-hour provincial air qualitive objective on three occasions at the nine Ministry and Ontario Hydro monitoring sites. In one case, the elevated reading was caused by emissions from a sulphur fire, which also resulted in some vegetation injury. Daily and annual air quality objectives for sulphur dioxide were consistently met. Total reduced sulphur, often responsible for offensive odours near kraft pulp mills, moderately exceeded the Ontario guideline during 26 hours in 1979 near Great Lakes Forest Products Limited. An emission inventory report on all sources of malodorous gases at Great Lakes will be available by the end of 1980.

INTRODUCTION

The Ministry of the Environment has conducted an air quality monitoring programme in Thunder Bay since 1963, when the first dust sampler was installed at 14 Algoma Street. By 1979, the network had expanded to 28 instruments at 16 sites to record dustfall, suspended particulate matter, soiling index, sulphur dioxide and total reduced sulphur. To monitor air quality in the vicinity of their Mission Island thermal generating station, Ontario Hydro also operates seven sulphur dioxide analysers in Thunder Bay and the surrounding area.

In addition to the monitoring programme described above, the Ministry conducted several special surveys during the year near specific local industries, including pulp mills (Abitibi-Price and Great Lakes Forest Products), a coal terminal (Thunder Bay Terminals Limited), and a brick plant (Thunderbrick Limited) in Rosslyn, 15 km (kilometres) west of Thunder Bay. Brief summaries of each of these investigations are presented in this report.

PARTICULATE POLLUTANTS

DUSTFALL

Dustfall, which comprises particulate matter that settles out from the atmosphere by gravity, has been monitored in Thunder Bay since 1970. The method of measurement is described in an earlier report (1). All dustfall weight determinations, chemical analyses, and microscopic examinations were performed at the Ministry's Thunder Bay laboratory. In 1979, the pH of dustfall solutions was determined for those samples containing water. Analysis for soluble sulphate was carried out for three sites, and samples from four locations were submitted for microscopic examination to identify the major components of the insoluble portion of dustfall.

Total dustfall for 16 of the sites shown in Figure 1 is summarized for the year in Table 1. There were very few excursions above the monthly air quality objective of 7 g/m^2 (grams per square metre), and dustfall exceeded the annual objective (4.6 g/m^2) at only two locations, compared with three in 1978 and four in 1977. The pH values for dustfall solutions (Table 2) were determined for the first time in 1979. The highest average pH readings were obtained at two sites (stations 63046 and 63047) near Great Lakes Forest Products Limited, and the lowest at station 63021, near Valley Camp Limited. Most readings were acidic, with an overall average of pH 4.3 for the year's samples. Because there are no historical data, the significance or usefulness of dustfall pH measurements are not known. The information may serve as a crude indicator of precipitation acidity, may eventually provide evidence of long-term trends, and may identify local or regional sources of alkaline or acidic fallout.

Analysis of dustfall for sulphate showed that sulphate concentrations at two sites near Great Lakes Forest Products were higher than those at the Ontario Government Building on James Street. However, the sulphate level at each of the three sites averaged less than 1 g/m^2 and was not considered excessive.

The identity of components of insoluble dustfall is set out in Table 3. For stations 63024 and 63026, located near grain elevators, grain dust was the dominant constituent of dustfall and accounted for about half the total dustfall recorded at these two sites. At stations 63005 and 63040, farther from grain elevators, road dust was the most important component and was responsible for a little over a third of the average dustfall measured at those locations. Results in 1977 were similar. It should be noted that while grain dust and road dust were the most frequently identified contaminants in dustfall, neither type of particle, alone or in combination, resulted in total dustfall reaching undesirably high levels.

As in earlier years, average dustfall was highest in spring and summer and lowest in fall and winter. This pattern is typical of most communities in Ontario, where the disturbance of dust on the ground is inhibited during periods when the ground is frozen or snow-covered.

At the 13 sites where historical data are available, average dustfall levels declined significantly in the past 7 years. Table 4 and Figure 2 indicate that Thunder Bay dustfall decreased 40 percent during this period. Figures 4a and 4b illustrate the areas of the City in compliance with the provincial air quality objective (annual average < 4.6 g/m^2) in 1973 and 1979. In 1973, dustfall exceeded the annual objective at nine stations. By 1979, only one station reported dustfall above the acceptable level.

SUSPENDED PARTICULATE MATTER

Suspended particulate matter comprises dust particles of small size and is measured with a high-volume sampler for a 24-hour period every sixth day. A description of the sampling and analytical method is contained in a recently issued Ministry report (2).

Total suspended particulate matter (TSP) exceeded the 24-hour Ontario air quality objective of 120 µg/m^3 (micrograms of suspended particulate matter per cubic metre of air) 12 percent of the time in 1979 (Table 5), compared with 6 percent in 1978. Most violations occurred in spring and early summer, with very few in the last 5 months of the year. Nearly all of the high readings were recorded between mid-March and early August at station 63017 (on Memorial Avenue in the Inter-City area), but the source of the dust could not be identified. The occurrence, at all sites, of higher readings in spring and summer and lower values in fall and winter followed the expected seasonal pattern. The annual objective (60 µg/m^3, geometric mean) for TSP was exceeded at two of the seven locations where samplers were operated in 1979.

City-wide TSP averages are compared in Table 6 for the period 1973 to 1979, and illustrated by the bar graph in Figure 3. Except for the significant increase at station 63017, average TSP showed little change from 1978 to 1979. The high concentration at 63017, however, resulted in the City average increasing from 42 $\mu g/m^3$ in 1978 to 49 $\mu g/m^3$ in 1979. Although higher than the figure for 1978, the 1979 average was still well below the value of 70 $\mu g/m^3$ recorded in 1973. The concentrations of suspended particulate matter in Thunder Bay in 1979 were approximately similar to those found in Ottawa, Kingston, Sudbury and London, and much lower than levels reported for large urban centres like Toronto, or industrial cities such as Hamilton or Windsor.

The general improvement in dustfall and TSP levels in recent years is attributed to the multi-million dollar dust abatement programme now virtually completed at the 12 operating grain elevators in Thunder Bay. Since the principal industrial sources of particulate emissions are now controlled, further significant reductions in dust levels are not anticipated, although annual fluctuations may occur because of variations in climate.

The concentrations of selected metals, nitrate, and sulphate in TSP at two Thunder Bay monitoring locations are summarized in Table 7. The levels of metals continued to be found at the low concentrations reported for other years. All values complied with Ontario regulations. While average values of nitrate and sulphate showed little change from other years, there were a few significantly elevated readings. The highest values occurred on February 20, and elevated concentrations of nitrate and sulphate were found throughout Ontario on the same date. Although the cause of this province-wide episode is still under investigation, a preliminary assessment suggests that long-range transport might be involved. At the two stations in Thunder Bay for which nitrate

and sulphate analyses were performed, there was a fairly good correlation between TSP, nitrate and sulphate at one station and the same parameters at the other site. This finding suggests that these contaminants may have had a common origin. Highest nitrate and sulphate levels were associated with east to northeast winds, and lowest concentrations with west or north winds. The occurrence of highest readings with easterly winds was unexpected, since there are no known sources in that direction which could significantly contribute to atmospheric concentrations of nitrate or sulphate.

SOILING INDEX

Soiling index measures the soiling or darkening properties of suspended particulate matter. The method, described in an earlier report (1) has the advantage of producing data continuously and automatically.

The soiling index results for 1979, shown in Table 8, were similar to the levels monitored in preceding years. The maximum 24-hour reading of 0.5 COH (coefficient of haze) was well below the maximum acceptable level of 1.0 COH. The annual averages at both Thunder Bay sites (0.14 and 0.15 COH) were also well within the objective of 0.5 COH. Elevated soiling index values were recorded on February 20, when high nitrate and sulphate concentrations occurred in suspended particulate matter.

GASEOUS POLLUTANTS

SULPHUR DIOXIDE

Sulphur dioxide (SO_2) is one of the world's major atmospheric pollutants and has many well-documented adverse effects on human health, vegetation, and property. It is also one of

the principal precursors to acid precipitation formation. The main industrial SO_2 sources in Thunder Bay are the Ontario Hydro generating stations, sulphite pulp mills, and some industrial boilers. Total emissions for all sources in the area are not large, and are estimated to be less than 100 metric tons per day.

In 1979, the Ministry operated two continuous SO_2 analyzers in Thunder Bay (a Philips model 9755 and a TECO model 43) and Ontario Hydro had an additional seven instruments in their network (5 Philips model 9700 and 2 Beckman model 953). The data for all nine sites are summarized in Tables 9 and 10.

The Ministry's two monitors recorded acceptable SO_2 concentrations at all times. The maximum hourly concentration of 0.24 ppm (parts per million) was recorded during the early evening of July 9 as a result of emissions from a sulphur fire on the property of Valley Camp Limited. Sulphur dioxide released by the burning sulphur gave rise to odour and vegetation damage complaints. The area of vegetation injury was estimated to involve 53 hectares, a much smaller zone than the 600-hectare area affected following a similar fire in 1977. Apart from this incident, all significant SO_2 readings (those greater than 0.10 ppm) at station 63040 were attributed to emissions from Ontario Hydro's power plant. All readings at St. Joseph's Hospital were very low.

Ontario Hydro reported three excursions slightly above the hourly objective for SO_2. Two of these occurred at the Mt. Mckay station (63041) and one, on July 9, at the Ford Street site (station 63048). The elevated reading at Ford Street was caused by SO_2 from the Vally Camp sulphur fire. The Mt. McKay episodes were probably due to emissions from either Ontario Hydro or Great Lakes Forest Products Limited. The daily and annual air quality objectives were met at all monitoring locations.

TOTAL REDUCED SULPHUR

Total reduced sulphur (TRS) comprises a group of sulphur-containing gases commonly associated with emissions from kraft pulp mills. At very low concentrations, TRS results in offensive odours. Higher levels may darken lead-based paint, cause vegetation injury, or result in temporary respiratory irritation.

The Ministry operates a continuous TRS monitor at a location about 1100 m (metres) from the Great Lakes Forest Products Limited kraft pulp mill. The data for 1979, given in Table 11 and Figure 5, are very similar to those for 1977 and 1978. The Ontario guideline for TRS, 27 ppb (parts per billion) hourly average concentration, was exceeded 26 times in 1979, compared with 28 in 1978. The maximum 1-hour average was 58 ppb in 1979, 48 in 1978 and 56 in 1977. An analysis of TRS concentrations and wind directions yielded the same results found in 1978: all the significant readings were obtained when the monitor was downwind of the kraft mill. The concentrations of TRS recorded in 1979 might cause periodic nuisance effects from the presence of unpleasant odours. A proposed control order to be issued later this year will require Great Lakes to identify all TRS emission sources and to bring all sources exceeding Ontario standards into compliance by the end of 1983.

SPECIAL SURVEYS

ABITIBI-PRICE

Vegetation assessment surveys have occasionally documented the occurrence of minor levels of sulphur dioxide injury near Abitibi-Price's sulphite pulp mills (1). Damage has always been restricted to company property. In 1979, there was no evidence of any injury around either of the company's two remaining sulphite mills in Thunder Bay.

GREAT LAKES FOREST PRODUCTS

A survey similar to the one described for Abitibi-Price was also carried out around Great Lakes' kraft and sulphite pulp mills. No evidence of sulphur dioxide injury symptoms were noted on vegetation, and none have been recorded to date since regular inspections began in 1975.

Results from a survey conducted with mobile monitoring equipment in July and August, 1978, have recently become available (5). The data from this study generally agreed with those from a similar investigation in 1977. Concentrations of TRS exceeded the Ontario guideline during approximately 2 percent of the total monitoring time. The maximum half-hour average concentration was 70 ppb, about 2½ times the guideline. TRS levels recorded by the mobile unit and by the Ministry's fixed station at Can-Car were similar when the mobile unit was at an equivalent distance from the Great Lakes kraft mill. Low, but measurable TRS concentrations were found in the south core area of Thunder Bay and in Vicker's Heights to the east of the mill. Analysis by gas chromatography indicated that about 46 percent of the TRS was hydrogen sulphide, 21 percent was methyl mercaptan, and 32 percent was ethyl mercaptan plus dimethyl sulphide.

Approximately 18 percent of the measurements of TSP made during the same 1978 survey at five sites around Great Lakes Forest Products exceeded the 24-hour provincial objective. Average TSP concentrations were highest at the location nearest the kraft mill and decreased by a factor of nearly 7 at the most distant monitoring location. TSP levels were usually highest downwind of the mill. The prominance of silicon and iron compounds in many samples of suspended particulate matter suggested that road dust and similar material entrained by wind or moving equipment in the vicinity of Great Lakes constituted much of the TSP measured.

THUNDER BAY TERMINALS

Pre-operational air and water quality environmental studies in the vicinity of the Thunder Bay Terminals Limited coal terminal on McKellar Island, Thunder Bay harbour, have been undertaken regularly since 1975 by Ministry staff and by the company's consultants. The most recently issued report, for 1978 (3), indicated that there was no increase in dust levels in areas near the terminal site following June, 1978, when the first coal shipments arrived by rail. The 1979 report, now being prepared, will show that there was no air pollution injury to vegetation and no increase in concentrations of any contaminant in vegetation or soil on or off the project site. Moss exposure experiments and snow sampling demonstrated the presence of elevated aluminum, arsenic, calcium, carbon and iron, but only in the immediate vicinity of the coal piles. Dustfall and suspended particulate levels were essentially unchanged from pre-operational conditions. All information to date indicates that the terminal is operating well and that no dust problems have developed.

THUNDERBRICK

The effects of emissions from a clay brick plant operated by Thunderbrick Limited in Rosslyn have been intensively investigated since 1978. These studies (4) showed that airborne fluoride discharged from the brick plant caused minor injury to sensitive vegetation within about 400 m of the emission source. The fluoride content of tree foliage on and off company property was also significantly elevated, but fluoride in forage in a pasture west of the brick plant was within Ontario regulations. Measurements of airborne fluoride showed that average fluoride concentrations near the brick plant significantly exceeded provincial objectives in the first part of 1979, but were usually acceptable after August, when clay consumption at the plant was sharply reduced. Fluoride levels never reached a point where a public health hazard was indicated. The company has agreed to take whatever measures are necessary to comply with Ontario air quality standards.

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3. Griffin, H. D. 1979. Air quality assessment, Thunder Bay Terminals Limited, Thunder Bay. 1978. Ontario Ministry of the Environment.

4. Griffin, H. D. and D. J. Racette. 1980. Air quality studies in the vicinity of Thunderbrick Limited, Rosslyn, 1979. Ontario Ministry of the Environment.

5. Ontario Ministry of the Environment. 1980. Ambient air survey in the areas of Thunder Bay, Red Rock, Marathon and Terrace Bay - 1978. ARB-TDA Report No. 47-80.

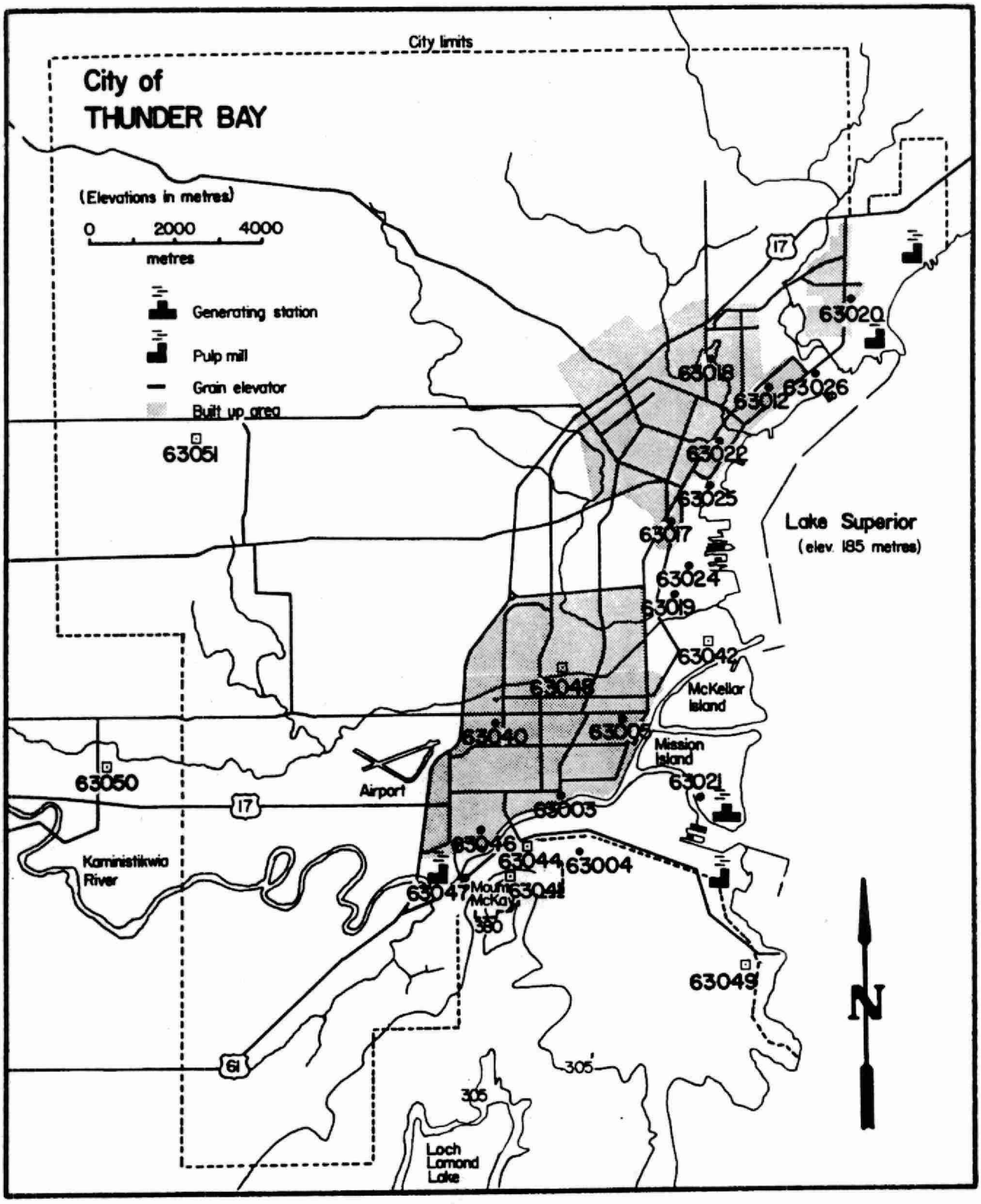

Figure 1. Air quality monitoring sites, 1979.

- • Ministry of the Environment
- ⊡ Ontario Hydro

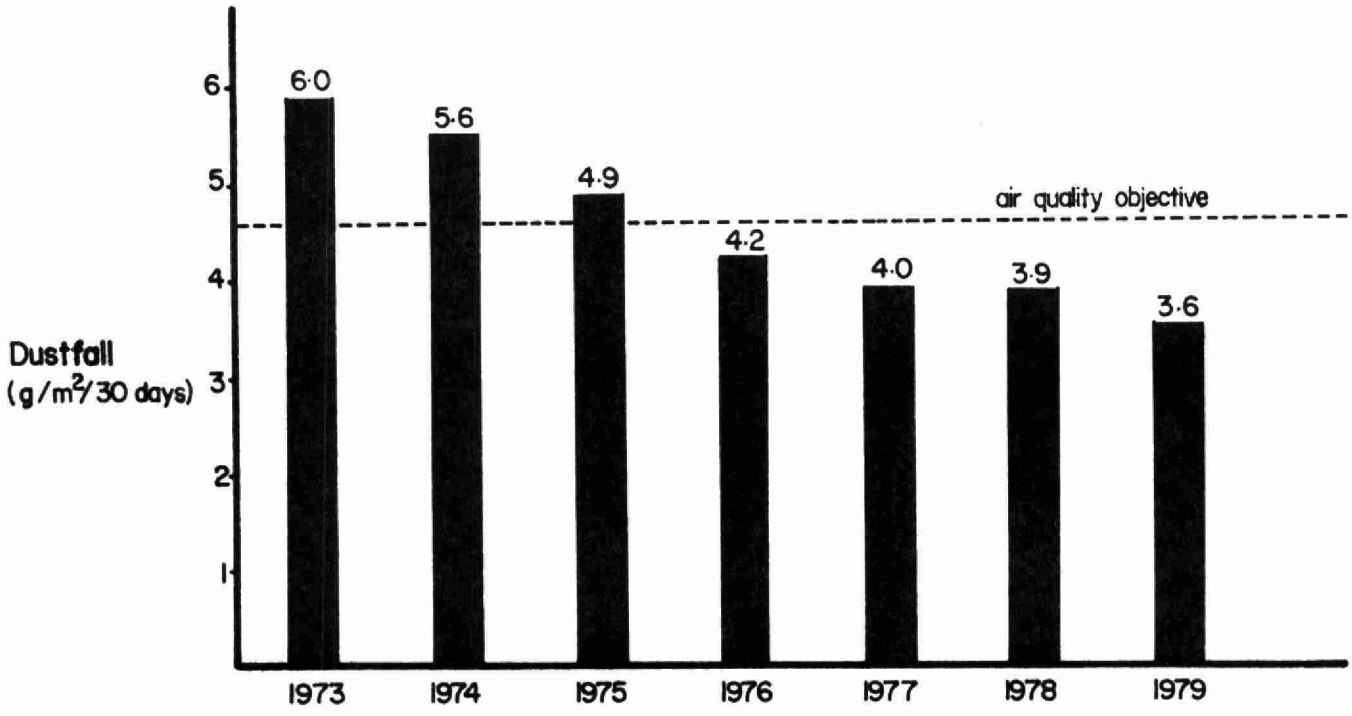

Figure 2. Average annual dustfall, 1973-1979, Thunder Bay.

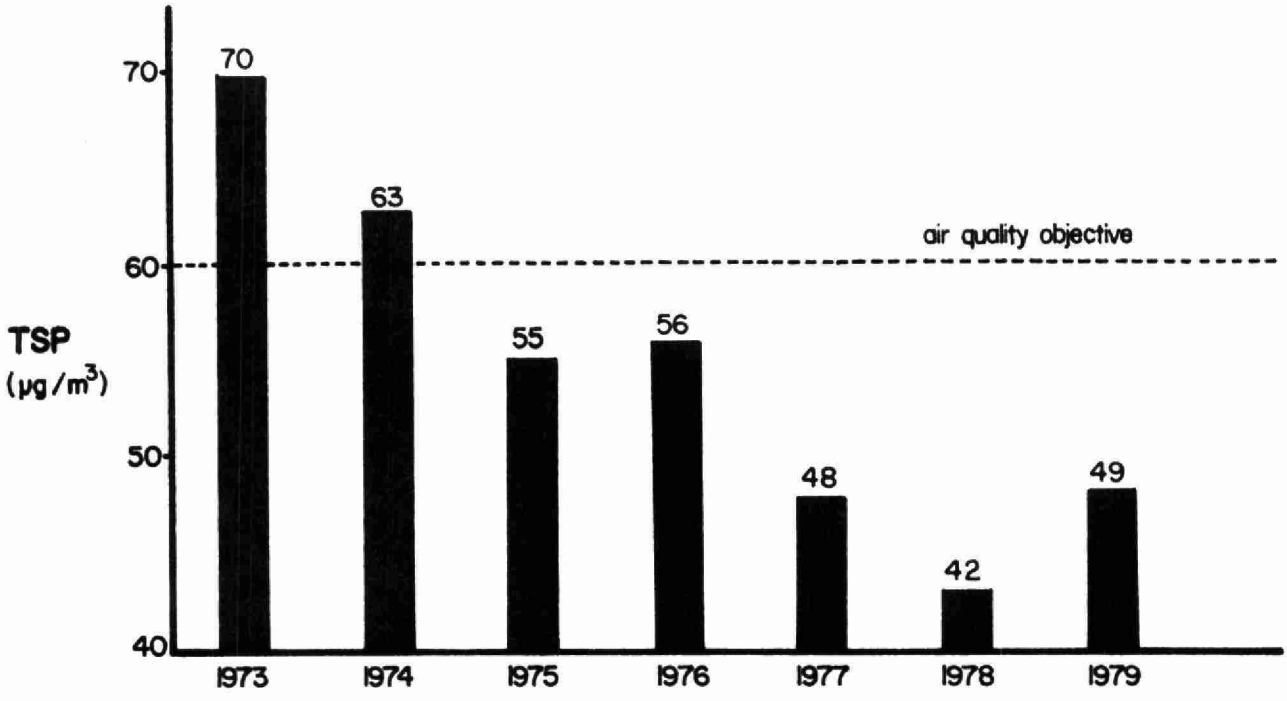

Figure 3. Average total suspended particulate matter ($\mu g/m^3$), 1973-1979, Thunder Bay.

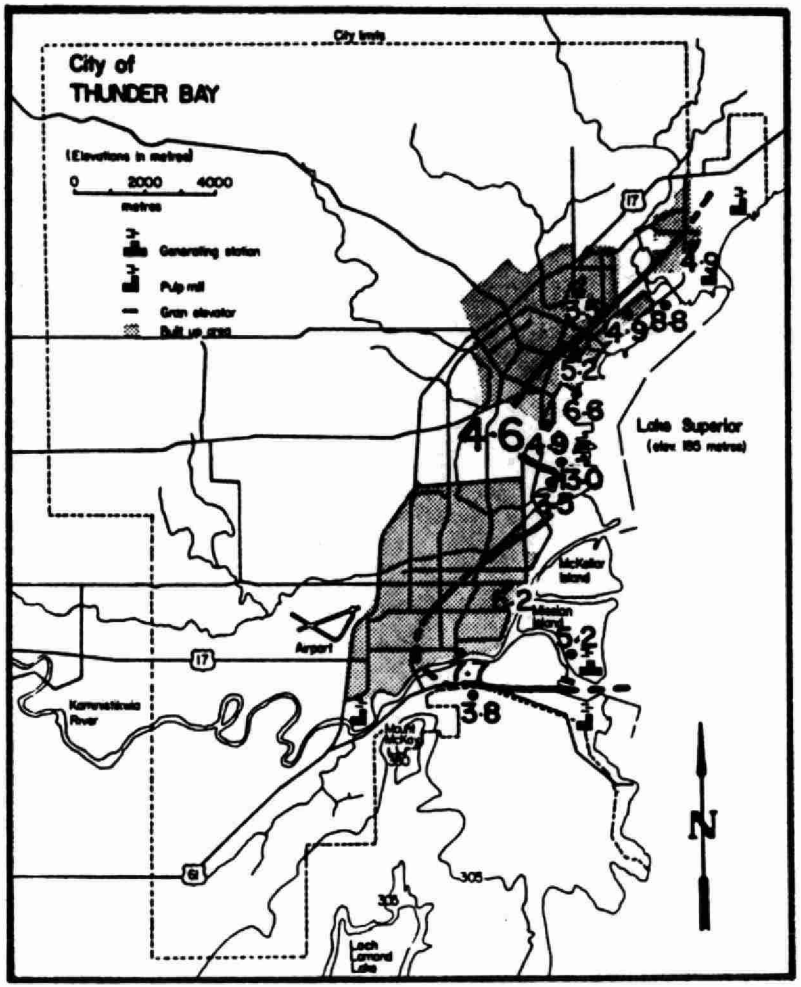

Figure 4a. Average dustfall, 1973 (g/m^2/30 days).

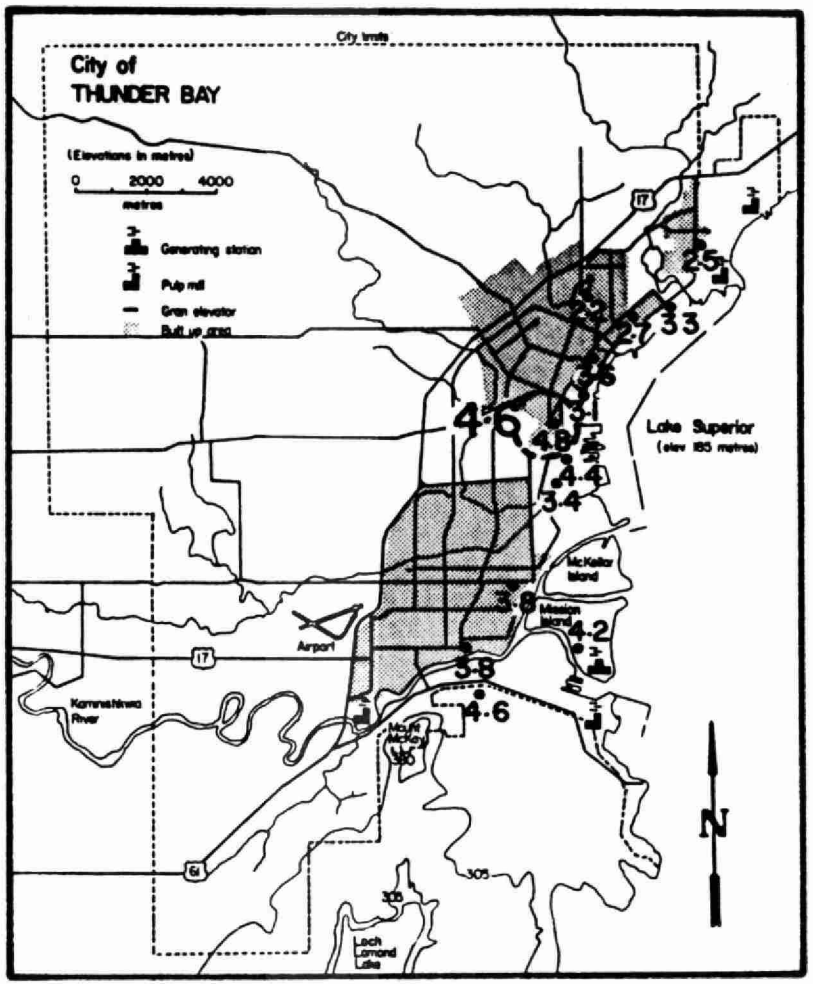

Figure 4b. Average dustfall, 1979 (g/m^2/30 days).

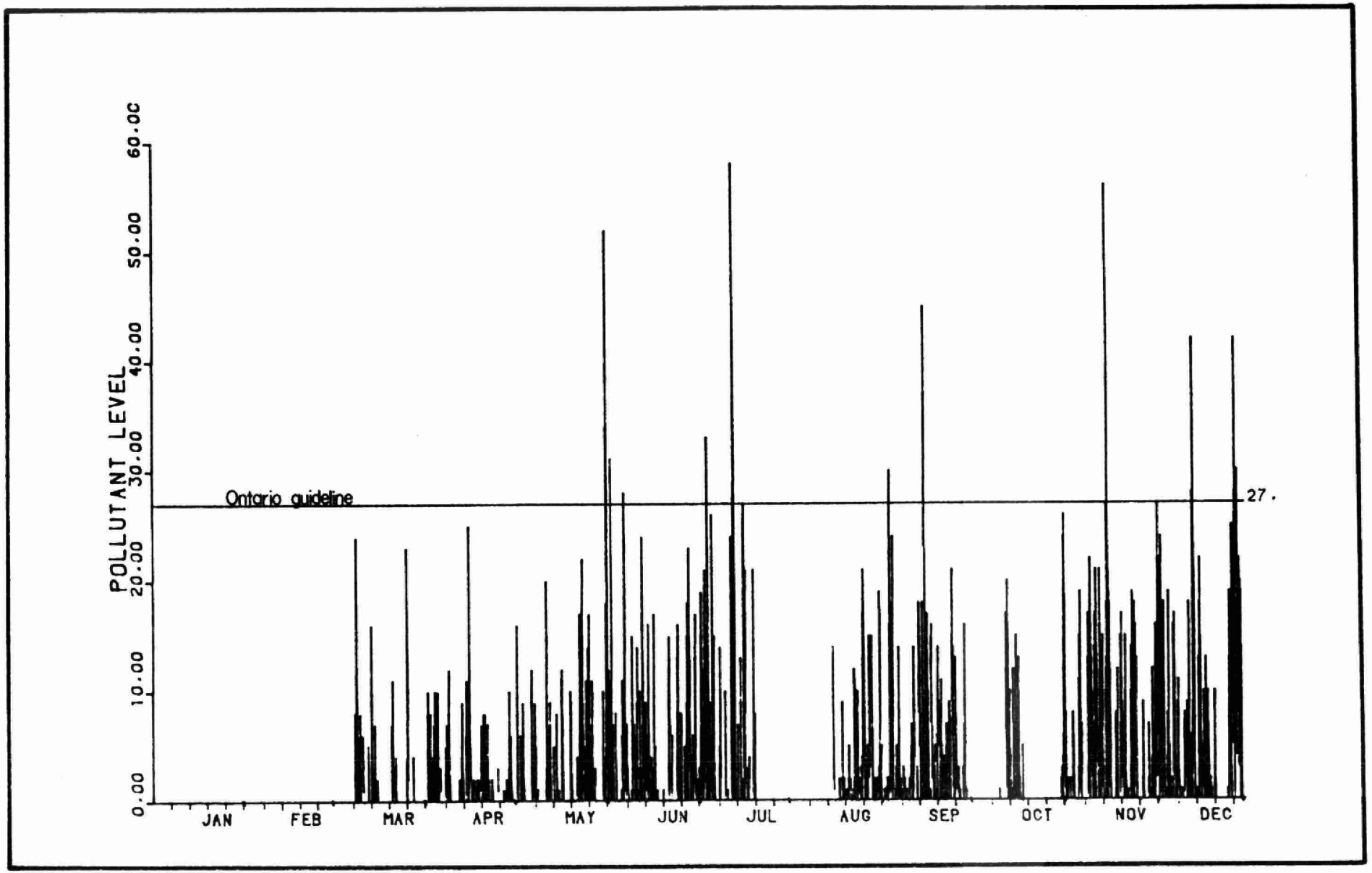

Figure 5. Hourly average TRS concentrations (parts per billion), station 63046, Thunder Bay, 1979.

TABLE 1. Total dustfall (g/m^2/30 days), Thunder Bay, 1979.

Station	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
63003	185 Gore Street	1.6	0.6	1.9	4.1	7.0	2.4	8.5	7.9	6.1	1.6	2.7	1.0	3.8
63004	24 Mountain Road	1.7	0.7	8.6	-	8.3	8.8	-	4.2	4.2	1.9	2.6	-	4.6
63005	McKellar Hospital	2.4	1.0	2.7	6.1	6.0	6.1	4.6	3.6	4.5	2.7	3.8	2.0	3.8
63012	Dawson Court	1.0	0.4	1.5	3.8	5.8	5.8	-	2.8	5.0	2.1	0.9	0.8	2.7
63017	521 Memorial Avenue	1.8	1.8	1.8	7.4	7.0	7.2	6.0	5.1	5.4	4.8	6.4	2.9	4.8
63018	St. Ignatius School	0.3	0.3	-	5.2	-	6.4	3.4	2.2	2.4	2.0	0.5	0.7	2.2
63019	Main St. Pumping Station	1.2	1.3	1.5	4.4	4.4	5.2	9.8	2.7	4.8	2.9	2.4	0.5	3.4
63020	Hodder Ave. Fire Hall	0.7	0.3	2.1	5.8	3.9	4.5	3.9	2.2	2.7	1.9	1.2	1.1	2.5
63021	Mission Island	3.8	1.5	2.4	5.5	3.9	6.7	6.5	3.2	4.4	1.6	8.9	1.5	4.2
63022	St. Joseph's Hospital	1.8	2.8	2.5	5.8	7.4	6.8	3.8	3.4	3.6	1.9	2.1	1.1	3.6
63024	Hammond Ave./Inter-City	7.5	1.5	2.0	3.4	7.3	5.6	13.7	-	3.2	1.9	1.8	0.3	4.4
63025	Manitou Street	1.0	0.5	1.6	3.4	5.6	6.3	5.7	3.8	4.0	2.3	2.0	0.7	3.1
63026	North Cumberland Hydro	1.8	1.3	1.6	4.1	6.0	7.4	4.6	3.7	3.7	2.4	1.8	1.1	3.3
63040	435 James St. South	1.6	0.7	1.4	4.5	3.9	4.0	3.4	3.2	3.3	2.3	2.8	1.0	2.7
63046	Montreal Street	4.6	2.2	2.5	7.0	7.8	9.2	4.4	9.2	9.5	6.1	7.4	4.9	6.2
63047	Totem Trailer Court	2.8	0.1	3.0	4.2	6.7	7.3	-	-	4.7	3.8	6.7	1.8	4.1

[a]Values exceeding maximum acceptable levels of 7.0 (monthly) or 4.6 (annual average) are underlined.

TABLE 2. Level of pH in dustfall solutions, Thunder Bay, 1979

Station	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
63003	185 Gore Street	5.8	4.2	4.4	6.5	6.5	-[a]	7.4	7.1	7.0	5.9	7.0	7.2	5.0
63004	24 Mountain Road	5.8	4.2	4.1	-	5.8	-	-	7.1	7.1	6.0	7.5	-	4.7
63005	McKellar Hospital	4.5	4.2	4.3	4.2	4.4	-	7.3	5.1	5.7	4.2	7.3	-	4.5
63012	Dawson Court	4.8	4.2	4.9	4.2	5.9	-	-	4.7	7.0	4.0	4.2	3.9	4.3
63017	521 Memorial Avenue	4.4	4.1	4.3	4.0	4.7	-	7.2	4.5	4.7	4.2	5.6	-	4.4
63018	St. Ignatius School	4.1	4.3	-	4.6	-	-	5.3	3.9	4.2	4.0	4.3	4.2	4.2
63019	Main St. Pumping Station	5.6	4.1	4.2	4.4	4.2	-	6.4	5.7	5.2	3.9	6.0	-	4.4
63020	Hodder Ave. Fire Hall	4.2	5.6	4.9	4.3	4.6	-	6.0	4.3	6.5	4.0	4.2	-	4.4
63021	Mission Island	4.9	4.0	4.1	3.8	3.9	-	3.8	3.6	3.2	3.7	3.2	-	3.6
63022	St. Joseph's Hospital	5.1	4.4	4.6	4.5	5.8	-	5.6	4.3	4.8	3.9	5.8	3.9	4.1
63024	Hammond Ave./Inter-City	8.7	4.2	4.1	6.7	7.2	-	8.3	-	4.3	4.0	4.4	-	4.4
63025	Manitou Street	5.0	4.1	4.3	3.7	4.2	-	6.6	4.1	4.1	3.8	4.4	-	4.1
63026	North Cumberland Hydro	4.3	5.0	4.9	3.8	4.7	-	5.7	4.0	4.2	3.9	4.3	3.8	4.1
63040	435 James St. South	4.2	5.2	4.2	3.9	4.0	-	4.7	5.0	4.6	4.1	5.7	4.5	4.3
63046	Montreal Street	7.4	6.2	6.1	7.0	7.2	-	-	7.6	7.9	6.9	8.3	8.0	6.7
63047	Totem Trailer Court	6.8	4.8	4.4	4.3	6.1	-	-	7.1	7.2	6.2	7.6	7.6	5.0

[a]Dustfall jar dry for all samples in June.

TABLE 3. Average composition of insoluble dustfall at four Thunder Bay monitoring stations, 1977 and 1979.

Contaminant	McKellar Hospital 63005				Hammond Avenue 63024				North Cumberland 63026				James Street South 63040			
	1977		1979		1977		1979		1977		1979		1977		1979	
	g/m^2	%[a]	g/m^2	%	g/m^2	%	g/m^2	%	g/m^2	%	g/m^2	%	g/m^2	%	g/m^2	%
Grain dust	0.4	7	0.5	14	1.2	27	2.0	45	2.5	52	1.8	55	0.2	6	0.1	5
Road dust	1.7	34	1.2	33	0.5	11	0.4	10	0.2	5	0.4	11	0.4	18	1.2	44
Fly ash	0.3	6	0.3	7	<0.1	2	<0.1	2	<0.1	2	<0.1	2	0.3	11	<0.1	3
Coke	0.3	6	<0.1	1	0.2	5	<0.1	<1	<0.1	<1	<0.1	<1	<0.1	2	<0.1	<1
Wood char	<0.1	<1	<0.1	<1	<0.1	2	<0.1	<1	<0.1	1	<0.1	2	<0.1	<1	<0.1	3
Other[b]	0.7	14	0.8	20	0.4	9	<0.1	2	<0.1	<1	<0.1	<1	0.3	12	0.3	12
TOTALS	3.4	67	2.8	75	2.4	56	2.6	60	3.0	61	3.3	73	1.2	49	1.8	67

[a]Percent of average annual total dustfall.

[b]Includes coal, wood fibres, insect parts and other biological matter, metals, tar, and unidentified material.

TABLE 4. Average dustfall (g/m^2/30 days), Thunder Bay, 1973-1979.

Station	1973	1974	1975	1976	1977	1978	1979	Seven-year average
63003	7.7[a]	7.4	4.6	4.2	4.7	4.8	3.8	5.3
63004	3.9	3.9	3.5	3.2	3.7	3.6	4.6	3.8
63005	5.3	5.3	4.9	3.5	5.0	3.8	3.8	4.5
63012	4.9	4.6	3.5	3.5	3.6	3.7	2.7	3.9
63017	4.9	6.0	5.3	4.9	4.9	4.4	4.8	5.0
63018	3.5	3.5	2.5	3.2	2.0	2.7	2.2	2.8
63019	3.5	7.0	3.5	4.2	3.8	4.0	3.4	4.2
63020	4.9	5.3	5.6	3.5	2.8	2.9	2.5	3.9
63021	5.3	5.3	6.7	5.6	4.6	4.3	4.2	5.1
63022	5.3	5.6	4.2	3.9	3.7	3.5	3.6	4.3
63024	13.0	10.2	7.7	5.3	4.4	5.3	4.4	3.9
63025	6.7	4.6	4.6	3.9	3.8	3.2	3.1	4.3
63026	8.8	6.7	6.0	5.6	4.9	4.9	3.3	5.7
Average, all locations	6.0	5.6	4.9	4.2	4.0	3.9	3.6	
Stations above objective (%)	77	69	46	31	31	23	8	

[a]Values exceeding maximum acceptable level of 4.6 (annual average) are underlined.

TABLE 5. Total suspended particulate matter ($\mu g/m^3$), Thunder Bay, 1979.

Date	Stations						
	63005	63012	63017	63018	63022	63040	63046
Jan 3	-	-	-	-	-	-	-
9	19	-	-	-	16	13	24
15	34	-	37	-	49	20	79
21	15	9	15	-	10	11	17
27	-	-	-	-	-	-	-
Feb 2	-	-	-	-	-	-	-
8	-	-	151[a]	30	-	-	39
14	20	-	110	4	45	17	-
20	87	66	220	39	82	74	-
26	44	5	73	8	46	36	-
Mar 4	18	9	-	14	45	14	-
10	22	4	103	13	-	15	-
16	76	66	160	69	70	74	96
22	47	33	156	37	40	37	48
28	45	20	137	26	48	33	30
Apr 3	75	52	265	66	72	51	61
9	53	30	152	-	52	48	59
15	52	21	181	37	32	22	59
21	78	38	208	61	69	-	74
27	111	88	302	-	81	34	104
May 3	65	29	171	-	50	57	73
9	65	58	258	62	69	48	52
15	96	82	223	76	54	46	60
21	58	21	175	-	27	37	50
27	128	66	-	94	58	83	88
Jun 2	63	-	187	-	47	-	202
8	156	93	267	134	-	77	130
14	146	144	337	173	138	127	210
20	55	53	153	104	-	71	125
26	-	49	200	139	62	88	162
Jul 2	45	34	172	43	39	44	103
8	75	60	191	83	67	97	174
14	88	-	250	106	85	132	243
20	76	46	225	60	53	99	172
26	49	42	183	48	45	50	86

TABLE 5. Continued.

Date	Stations						
	63005	63012	63017	63018	63022	63040	63046
Aug 1	230	53	124	61	63	56	134
7	46	32	83	64	47	80	-
13	29	-	38	22	24	32	-
19	51	46	70	80	55	66	78
25	26	19	67	-	38	38	62
31	44	20	49	-	34	39	41
Sep 6	52	16	-	28	29	34	69
12	45	35	100	45	54	36	48
18	50	23	101	27	40	31	65
24	52	21	90	53	55	72	92
30	47	-	58	30	32	33	56
Oct 6	-	12	50	10	20	18	20
12	39	10	40	16	16	17	20
18	72	28	102	49	32	38	91
24	56	10	83	15	21	-	20
30	80	39	65	49	66	-	69
Nov 5	31	13	63	21	26	27	85
11	46	21	43	28	-	39	-
17	50	23	37	22	20	8	64
23	41	10	33	10	19	-	43
29	26	11	16	-	18	16	36
Dec 5	37	18	31	19	28	27	42
11	32	15	16	13	20	14	33
17	43	5	-	24	30	-	80
23	29	14	23	14	18	32	32
29	36	14	38	14	26	-	87
Annual geometric means:	51	26	95	35	39	38	66

[a]Values exceeding maximum acceptable level of 120 $\mu g/m^3$ (24-hour average) are underlined.

TABLE 6. Average concentrations ($\mu g/m^3$) of suspended particulate matter, Thunder Bay, 1973-1979.

Station	Location	1973	1974	1975	1976	1977	1978	1979	Seven-year average
63005	McKellar Hospital	69[a]	61	51	49	47	44	51	53
63012	Dawson Court	59	51	47	47	40	37	26	44
63017	521 Memorial Avenue	107	102	85	82	69	56	95	85
63018	St. Ignatius School	40	40	36	37	34	33	35	36
63022	St. Joseph's Hospital	74	60	55	66	49	42	39	55
	Average, all stations	70	63	55	56	48	42	49	
	Stations exceeding objective (%)	60	40	20	40	20	0	20	

[a]Values exceeding maximum acceptable level of 60 $\mu g/m^3$ (annual geometric mean) are underlined.

TABLE 7. Concentrations ($\mu g/m^3$, 24-hour averages) of heavy metals, nitrate and sulphate in suspended particulate matter, 1979.

Contaminant	Station 63005[a] Range	Station 63005[a] Average	Station 63022[b] Range	Station 63022[b] Average
Cadmium	ND[c] - <0.01	<0.01	ND - 0.06	<0.01
Chromium	ND - 0.01	<0.01	ND - 0.01	<0.01
Copper	ND - 0.21	0.11	0.09 - 0.51	0.30
Iron	0.14 - 9.48	2.29	ND - 5.06	0.91
Lead	0.10 - 0.58	0.26	0.05 - 0.90	0.26
Manganese	<0.01 - 0.13	0.04	ND - 0.13	0.03
Nickel	ND - 0.01	<0.01	ND - <0.01	<0.01
Nitrate	<0.10 - 7.60	1.30	<0.10 - 11.30	1.10
Sulphate	1.50 - 24.70	6.10	1.20 - 49.40	5.50
Vanadium	ND - 0.03	<0.01	ND - 0.02	<0.01
Zinc	ND - 0.14	0.03	0.01 - 0.35	0.04

[a] 37 samples for metals, 55 for nitrate and sulphate.

[b] 49 samples for metals, 53 for nitrate and sulphate.

[c] not detectable.

TABLE 8. Distribution of soiling index readings (2-hour averages) in Thunder Bay, 1979.

Month	Days of data	No. of readings for COH[a] values of: 0.0-0.4	0.5-1.0	1.1-1.5	>1.5	Maximum values: 2-hour	24-hour
				Station 63022			
Jan	31	359	12	0	0	0.9	0.3
Feb	28	287	44	4	0	1.3	0.5
Mar	28	309	21	2	0	1.2	0.4
Apr	29	330	22	0	0	0.8	0.4
May	31	346	26	0	0	0.9	0.4
Jun	21	256	5	0	0	0.8	0.3
Jul	31	364	8	0	0	0.7	0.2
Aug	31	367	5	0	0	0.7	0.3
Sep	22	270	0	0	0	0.4	0.2
Oct	20	242	2	0	0	0.7	0.2
Nov	29	350	4	0	0	0.5	0.2
Dec	31	365	7	0	0	0.5	0.2
YEAR	332	3845	156	6	0	1.3	0.5
				Station 63040			
Jan				no data			
Feb	28	261	56	1	0	1.3	0.5
Mar	26	297	24	1	0	1.1	0.5
Apr	27	317	11	0	0	0.7	0.2
May	28	337	3	0	0	0.7	0.2
Jun	30	337	23	0	0	0.9	0.3
Jul	30	329	33	0	0	0.9	0.3
Aug	31	353	19	0	0	0.9	0.3
Sep	29	334	16	0	0	1.0	0.4
Oct	25	298	13	0	0	0.7	0.3
Nov	30	335	23	1	0	1.3	0.4
Dec	31	352	18	0	0	1.0	0.4
YEAR	315	3550	239	3	0	1.3	0.5

[a]coefficient of haze per 1,000 linear feet of air.

TABLE 9. Distribution of sulphur dioxide readings (pphm[a], hourly averages) at Ministry of the Environment monitoring stations, Thunder Bay, 1979.

Month	Days of data	No. of readings for concentrations of: 0-5	6-10	11-15	16-25	>25	Maximum values: Hour	Day
		Station 63022 (St. Joseph's Hospital)						
Jan	31	740	0	0	0	0	1	0
Feb	28	670	0	0	0	0	3	1
Mar	31	743	0	0	0	0	5	1
Apr	30	720	0	0	0	0	4	1
May	31	737	0	0	0	0	3	1
Jun	30	715	0	0	0	0	3	1
Jul	31	735	1	0	0	0	10	1
Aug	29	694	0	0	0	0	4	1
Sep	30	716	0	0	0	0	5	1
Oct	27	664	0	0	0	0	4	0
Nov	28	689	1	0	0	0	7	1
Dec	31	744	0	0	0	0	3	1
YEAR	357	8567	2	0	0	0	10	1
		Station 63040 (435 James Street South)						
Jan	31	737	0	0	0	0	3	0
Feb	28	654	0	0	0	0	1	0
Mar	25	574	1	0	0	0	8	1
Apr	27	649	1	0	0	0	7	1
May	31	673	0	0	0	0	4	1
Jun	30	702	0	0	0	0	3	0
Jul	29	696	5	0	1	0	24	2
Aug	31	742	0	2	0	0	11	1
Sep	30	711	3	0	0	0	9	1
Oct	31	715	3	1	0	0	12	2
Nov	30	683	3	0	0	0	10	2
Dec	24	616	0	0	0	0	3	1
YEAR	347	8152	16	3	1	0	24	2

[a]parts of sulphur dioxide per hundred million parts of air

TABLE 10. Distribution of sulphur dioxide readings (ppb[a], hourly averages) at Ontario Hydro monitoring stations, Thunder Bay, 1979.

Month	Days of data	No. of readings for concentrations of: 0-49	50-99	100-149	150-250	>250	Maximum values: Hour	Day
				Station 63041 (Mt. McKay)				
Jan				no data				
Feb	24	596	4	2	1	0	216	16
Mar	31	735	7	2	0	0	117	13
Apr	30	707	8	2	3	0	188	27
May	31	737	2	2	1	0	220	24
Jun	26	640	6	1	0	0	140	11
Jul	31	739	3	1	0	0	103	17
Aug	31	712	13	8	4	2	319	52
Sep	27	662	2	1	1	0	160	22
Oct	31	737	3	0	0	0	74	12
Nov	30	710	6	1	1	0	204	14
Dec	31	740	4	0	0	0	92	13
YEAR	327	7715	58	20	11	2	319	52
				Station 63042 (East End)				
Jan	31	712	29	2	0	0	113	31
Feb	26	613	28	2	0	0	105	24
Mar	27	688	1	1	0	0	115	14
Apr	30	720	0	0	0	0	49	12
May	31	740	2	0	0	0	56	10
Jun	28	689	2	0	0	0	52	7
Jul	31	733	5	0	0	0	73	16
Aug	31	728	7	3	0	0	137	15
Sep	30	713	2	1	0	0	118	11
Oct	31	742	2	0	0	0	72	7
Nov	30	715	1	0	0	0	57	5
Dec	16	405	0	0	0	0	37	14
YEAR	342	8198	79	9	0	0	137	31

[a]parts of sulphur dioxide per billion parts of air

TABLE 10. Continued.

Month	Days of data	No. of readings for concentrations of: 0-49	50-99	100-149	150-250	>250	Maximum values: Hour	Day
				Station 63044 (James Street)				
Jan	31	740	0	1	1	0	153	13
Feb	28	669	3	0	0	0	77	12
Mar	30	735	3	0	0	0	83	14
Apr	30	719	1	0	0	0	96	10
May	30	718	5	0	0	0	92	15
Jun	30	710	0	0	0	0	34	7
Jul	31	741	1	0	0	0	94	8
Aug	31	738	2	1	0	0	102	9
Sep	30	712	2	0	0	0	70	9
Oct	31	740	0	0	0	0	30	7
Nov	29	708	0	0	0	0	41	9
Dec	31	744	0	0	0	0	22	5
YEAR	362	8674	17	2	1	0	153	15
				Station 63048 (Ford Street)				
Jan	29	702	0	0	0	0	20	7
Feb	27	662	0	0	0	0	43	6
Mar	31	742	2	0	0	0	79	12
Apr	30	717	3	0	0	0	84	8
May	31	732	6	0	0	0	97	13
Jun	30	717	1	0	0	0	51	7
Jul	31	731	8	1	0	1	308	26
Aug	31	734	10	0	0	0	90	10
Sep	30	716	4	0	0	0	68	11
Oct	31	736	1	0	0	0	72	7
Nov	30	716	0	0	0	0	23	4
Dec	24	598	0	0	0	0	27	9
YEAR	355	8503	35	1	0	1	308	26

TABLE 10. Continued.

Month	Days of data	No. of readings for concentrations of: 0-49	50-99	100-149	150-250	>250	Maximum values: Hour	Day
				Station 63049 (Chippewa Park)				
Jan	31	737	3	2	0	0	137	20
Feb	28	666	6	0	0	0	68	14
Mar	24	585	7	0	2	0	165	21
Apr	22	539	0	1	0	0	118	10
May	22	556	0	0	0	0	35	8
Jun	30	718	0	0	0	0	18	2
Jul	31	728	0	0	0	0	43	3
Aug	31	742	2	0	0	0	73	12
Sep	30	714	0	0	0	0	49	8
Oct	31	712	25	7	0	0	144	67
Nov	29	691	6	4	0	0	145	27
Dec	23	556	2	0	0	0	69	8
YEAR	332	7944	51	14	2	0	165	21
				Station 63050 (Paipoonge)				
Jun	30	720	0	0	0	0	40	5
Jul	31	734	3	0	1	0	180	10
Aug	26	649	3	0	0	0	70	12
Sep	30	720	0	0	0	0	30	4
Oct	31	744	0	0	0	0	20	3
Nov	20	505	0	0	0	0	10	0
Dec	31	744	0	0	0	0	10	2
YEAR	199	4816	6	0	1	0	180	12
				Station 63051 (John Street)				
Jul	6	158	0	0	0	0	40	5
Aug	31	738	1	0	0	0	50	4
Sep	25	628	0	0	0	0	30	3
Oct	31	744	0	0	0	0	30	3
Nov	19	474	0	0	0	0	10	1
Dec	31	744	0	0	0	0	20	2
YEAR	143	3486	1	0	0	0	50	5

TABLE 11. Distribution of readings of total reduced sulphur (ppb[a], hourly averages) at station 63046, Thunder Bay, 1979.

Month	Days of data	No. of readings for concentrations of: 0-10	11-20	21-27	28-50	>50	Maximum values: Hour	Day
Jan					no data			
Feb					no data			
Mar	17	388	8	2	0	0	24	5
Apr	25	587	4	1	0	0	25	5
May	28	634	15	1	0	0	22	4
Jun	27	586	34	4	3	1	52	9
Jul	18	407	34	11	7	1	58	14
Aug	13	262	15	1	0	0	21	7
Sep	25	510	42	10	4	0	45	9
Oct	6	134	11	0	0	0	20	6
Nov	28	602	64	10	1	1	56	11
Dec	31	622	74	26	8	0	42	17
YEAR	218	4732	301	66	23	3	58	17

[a]parts of total reduced sulphur, expressed as hydrogen sulphide, per billion parts of air